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Challenges in the Multipolar Space-Power Environment

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Dedicated To

Muir S. Fairchild (1894 –1950), the first commander of Air University and the university's conceptual father. General Fairchild was part visionary, part keen taskmaster, and "Air Force to the core." His legacy is one of confidence about the future of the Air Force and the central role of Air University in that future.

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Foreword

Space power is arguably one of the most valuable, yet under-appreciated and misunderstood components of US national power. The effects derived from our presence in space have tremendous strategic implications: an explosion of communication capabilities, better weather prediction, precision navigation, and intelligence are but a few of the dividends derived from investments in space programs.

The United States no longer enjoys a near monopoly on space effects. Every week brings news of advances in space technologies by China, Russia, India, European powers, and others. Space, as a strategic medium (and probably a future war-fighting medium), is the ultimate high ground; it is now widely shared and could be hotly contested. Ranging from satellite-based access to Internet services to China's recent shoot down of one of its own satellites, new capabilities derived from space-based assets are accelerating in terms of quality, ingenuity, and importantly, availability to allies and enemies alike.

US leaders must understand the strategic implications of these advances. The authors have filled an important void in the literature on the role of space in strategic decision making by applying two models. The first is Col W. Michael Guillot's paper on strategic leadership, which serves as an excellent framework to analyze the space programs—and their significance—of three of the United States' peer competitors in space: China, India, and the European Union. By putting individual advances of these entities in their proper strategic context, the reader gains a broader and deeper understanding of the meaning of these advances. Additionally, the authors apply the familiar "VUCA" (volatility, uncertainty, complexity, and ambiguity) model to space programs, aiding the reader in developing a framework in which to analyze space-power advances.

The inevitable conclusion upon reading this paper is that senior decision makers must plan for a strategic landscape where the United States does not enjoy unmatched or uncontested benefits from space power. Additionally, the authors make specific policy prescriptions regarding further development of US space power, international cooperation regarding space programs and effects, and suggestions on de-escalation mecha-

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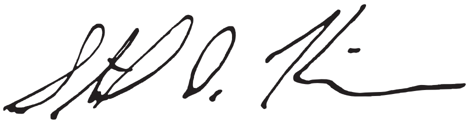
nisms for developing space-based conflicts. Modern Airmen must be familiar with the entire vertical dimension, and this paper serves as an excellent primer for that purpose.



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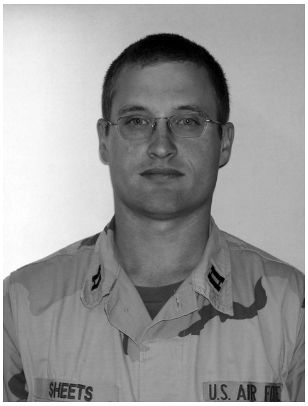
Capt Matthew Schmunk



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We would like to acknowledge the Air Force Institute of National Security Studies for making this study possible. Their interest inspired us to address this substantial topic, and their support backed our need for firsthand experience in the field.

We would also like to acknowledge all the individuals that have shared their candid views on space power with us in the past few years—it is an exciting time to be a space professional, based on the diverse and passionate interest we have encountered.

Lastly, we would like to thank Air University Press for recognizing the importance of this subject matter. We are proud to provide our contribution to the dialogue surrounding space power and look forward to participating in its continued evolution.

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Introduction

The United States embraces space to satisfy its strategic goals for domestic, national-security, and military purposes—augmenting each with international agreements. Distinct in policies, economics, doctrine, and supporting infrastructure, these elements define different spectra in the space-power continuum. The United States is no longer alone, however. More nations than ever before are turning to space to satisfy their own strategic goals. By examining foreign developments and strategies, we can paint in broad strokes a portrait of the space strategic environment for which the United States must prepare. The purpose of this analysis is twofold. First, by examining the domestic, national-security, military, and international efforts of emerging space powers, we implicitly conclude space's strategic importance is rapidly expanding. Second, we discuss the nature of the space environment and identify complexities current and future leaders will face. Ultimately, because the environment is increasingly multipolar, international engagement in many forms will be a necessary prerequisite to achieve and maintain space power now and in the future.

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Chapter 1

Modeling the Space-Power Continuum

Despite the distinct nature of each spectrum in the space-power continuum, there is complex interaction between any nation's domestic, national-security, and military space programs. Since a nation may use all or any of these elements, we propose that two key goals should be achieved by any strategic analysis of national-space programs. First, the examination should avoid sharp focus on only one aspect of a nation's space power at the risk of misunderstanding the complete picture. A nation's military may advertise certain capabilities, for example, but the national leadership or domestic concerns determine what intentions will become reality. Second, an ideal model can describe the nature of the strategic environment and what current and future preparations should be made. For these reasons, the models and concepts developed by Col W. Michael Guillot in *Strategic Leadership: Defining the Challenge* were found to be especially appropriate, and his work is used as a guide.

The purpose of Colonel Guillot's work was to highlight the complexity of the exercise of strategic leadership and to make the understanding of the strategic environment and leadership processes simpler.[1] To accomplish this, he chose a framework that broke the strategic leadership environment into domestic, military, national-security, and international-environmental segments. As Colonel Guillot states, this framework "illustrates how the strategic environment is interrelated, complementary, and contradictory," which are the precise subtleties we must expose when analyzing space power.[2] By viewing other nations' activities in this way, we gain insight into how foreign strategic leaders are shaping their own space power to meet current and future needs. Since "this construct is neither a template nor checklist—nor a recipe for perfection," it is necessary to briefly describe terms used in our analysis and acknowledge the assumptions and imperfections they may include.[3]

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Domestic Space Power

The domestic spectrum of space power consists of activities that directly benefit a nation's citizens. In most cases, this is achieved by allowing space service providers to profit by selling information or entertainment to consumers. Alternatively, a government can assume the role of service provider and create public resources or promote scientific advancement with space programs. Building domestic space power is usually a nation's primary focus—space assets form a commercial center of gravity and can be a source of national pride.

Some major factors complicate the domestic space power spectrum, however. First, since multinational corporations own and operate many space assets, difficulties arise when nations wish to regulate content or users of commercial systems, especially if those users are foreign. Second, domestic space assets can have secondary national-security or military roles, either when purchased or commandeered. For these reasons and more, understanding a nation's domestic goals is prerequisite to determining the concepts driving a nation's space power development.

National-Security Space Power

Colonel Guillot notes that "within the national-security environment, strategic leaders should consider national priorities and opportunities and must know the threats and risks to national security, as well as any underlying assumptions."[4] Space power's ability to help form leaders' opinions on national security is well documented. While some may argue national-security space power equates to military capability, its nature is fundamentally different. National-security space efforts have strategic implications that do not directly support operational or tactical levels of decision making. Superior command, control, communication, intelligence, surveillance, and reconnaissance (C3ISR), made possible by space-based intelligence assets and secure global satellite networks, greatly enhances a nation's ability to identify and evaluate foreign developments. Leaders can use space power to enable confident application of diplo-

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matic pressure, effective delivery of humanitarian aid, and optimal force posturing to send effective strategic messages.

Likewise, national-security space power can be undermined when analysts misinterpret data or fall victim to a camouflage, concealment, or deception campaign. Key indicators of impending foreign developments may be missed or misunderstood, with faulty information passing directly to strategic leadership. Because of this, national-security space power can also become a liability.

As more nations gain national-security space power, each develops a better understanding of its benefits and liabilities. Space power's broad reach results in better monitoring of both regional and global events, so more nations can apply independent judgment to data gathered. This represents a marked difference from decades of only one or two superpowers using space for these purposes. Many nations can carefully watch developments regarding claims to natural resources, border security, and deployments of military forces. They will share data with allies, publicly use it against adversaries and competitors, and double-check their own results with other nations' claims; this will all occur in an increasingly complex blend of agendas. Because of scenarios like these, careful understanding of national-security space power remains critical to understanding its impact on the strategic environment.

Military Space Power

Whereas national-security systems are structured to support strategic leadership, military space power is best defined by its ability to directly influence armed conflict at operational and tactical levels from space. To achieve this, national-strategic leaders must first define the manner in and extent to which space will be used in combat. Whether this definition results from a formal or an informal process, the result is a military doctrine that defines space power objectives and the ways and means of achieving them.

Because a nation implements military space power based on its overall strategy, a space power analysis should consider that strategy. For Colonel Guillot, there are two reasons why leaders should carefully consider military strategy as part of

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the strategic environment. "First, because the military instrument of power has such great potential for permanent change in the strategic environment, all strategic leaders must recognize its risks and limitations. Second, because military experience among civilian leaders has dwindled over the years and will continue to do so, strategic leaders have a greater responsibility to comprehend policy guidance and clearly understand expected results."[5]

Taken in the context of military space power, these concerns are great challenges to forging effective doctrine. The risk of causing "permanent change" in the strategic environment, for example, is a key consideration when debating if and how weapons should be used through, in, or from space. Then, once a doctrine is developed, the authors face the challenge of convincing others that it will deliver the desired results and then weather inevitable changes in civilian policy guidance. With these uncertainties and the fact that many aspects of military space power are yet untested by major conflict, the development and implementation of military space power will prove to be one of the most difficult and yet inevitable tasks to face in coming decades.

International Engagement

Nations can promote space power through their own space policies and by developing international regimes that establish standards of conduct with regard to activities in space. These regimes can include treaties, nonproliferation schemes, international sanctions, and international space law. By cooperation, both spacefaring nations and those without space capabilities can leverage international agreements into another kind of "space power." International efforts cannot be discounted. Colonel Guillot warns, "strategic leaders can be surprised and their decisions thwarted if they fail to understand the international environment sufficiently."[6]

Applying the Strategic Framework

Having recast Colonel Guillot's framework in terms of the space strategic environment, the next step will be to apply it in

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the cases of China, India, and the European Union. Each has its own space capabilities and liabilities, and all are regional powers seeking new opportunities. Each case study will include discussions of the respective domestic, national-security, military, and international spectrums. By doing so, we hope to gain insights into the future nature of the space strategic environment.

We acknowledge that these case studies are not exhaustive. Such an effort is far outside the scope of this work, but wherever possible, the most authoritative sources have been sought and translations have been kept in as much context as possible, while reserving the right to academic postulation and the use of anecdotal evidence.

Through this process, the following points became clear. First, because these nations are using space power to satisfy so many strategic functions, it implicitly shows the strategic importance of space. Second, the nature of the emerging multipolar space environment will lead to new challenges for strategic space leaders.

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

1. Guillot, "Strategic Leadership," 67.
2. Ibid., 68.
3. Ibid.
4. Ibid.
5. Ibid.
6. Ibid., 70.

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Chapter 2

China

Robust space power is critical to China's achievement of national greatness. Space development represents a key indicator of science and technology (S&T) innovation, which is core to China's national strategy—a point which cannot be overemphasized. Dr. Michael Pillsbury's report to the United States–China Economic and Security Review Commission, *China's Progress in Technological Competitiveness: The Need for a New Assessment*, explains the importance of China's S&T goals. It is interesting to note that a sizable six of 16 remarkable S&T achievements in Dr. Pillsbury's analysis are due to Chinese space efforts; all are key contributors to the Chinese concept of comprehensive national power (CNP),

> *CNP* ([综合国力] *zonghe guoli*) refers to the combined overall conditions and strengths of a country in numerous areas[. S]cience and technology have become increasingly important in the competition for power and influence in the world. Chinese analysts have developed their own extensive index systems and equations for assessing CNP. . . . [T]heir analytical methods are not traditional Marxist-Leninist dogma or Western social science but something unique to China, particularly the stress on the role of S&T as the primary factor that can bring national greatness to China.[1] (emphasis added)

This sentiment is core doctrine in the highest levels of Chinese government and offers incredible insight into China's grand strategy for space.

Pres. Hu Jintao, while addressing the Chinese Academy of Sciences (CAS) in June 2005, articulated a specific strategy to achieve the S&T power critical to China's success. He put forth three requirements to guarantee innovation:

- Provide clear strategic goals and achieve breakthroughs in key and core fields to solve major problems in China's economic and social development.
- Accelerate domestic scientific and technological systems.
- Foster talented people.[2]

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Ma Xingrui, vice president of China Aerospace Science and Technology Corporation (CASC), identifies that space technology as a key field and "an important sign of the national comprehensive power of a country, it is one of the high technologies that have the most significant impacts on modern society."[3] Where President Hu's comments highlight *how* China will foster innovation, national leaders like Ma Xingrui and others help detail *what* that innovation will focus on. These combined efforts result in what is probably the most carefully articulated and coordinated plan to achieve space power worldwide.

China seeks strategic breakthroughs in nearly all aspects of space. The 2000 "White Paper: China's Space Activities" indicates that by 2010, China hopes to

- Develop an Earth monitoring system to monitor the land, oceans, and atmosphere of China, surrounding regions, and the globe. This includes a comprehensive nationwide remote-sensing data reception, processing, and distribution system.
- Develop an independently operated broadcast and telecommunications system to form China's telecom industry.
- Develop an independent satellite navigation system.
- Improve space-launch systems capable of providing international launch services.
- Develop basic space science, including strengthened studies of materials, the environment, microgravity, and astronomy.
- Realize manned spaceflight.[4]

Independence is the most critical element noted throughout these national goals. Independence requires very strong domestic investment, support, and little or no reliance on external sources. The following sections will highlight China's progress towards these goals as well as some hurdles China faces.

Domestic Environment

China's domestic space power, whose complexity is often underestimated, is in surprisingly dynamic transition. As men-

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tioned before, nations can allow companies to sell services to citizens or the government can assume that role to bring space benefits to its citizens. In China, debate on the suitability of these two methods proves to be a major driver influencing its domestic space power. On the unlikely battlefield of satellite-television broadcast, we see how the sometimes contradictory influences of commerce and government are driving unique developments in both arenas.

One of China's greatest domestic space issues is to develop independently operated satellite broadcast and telecommunications. According to Ma Xingrui, "satellite communications technology has brought us up to a hundred services including telephone, telegraph, facsimile, data transmission, television broadcasting, satellite television education, mobile communications, data collection, rescue, e-mail and telemedicine, significantly changing our life styles."[5] However, satellite broadcast juxtaposes with a major concern for the People's Republic of China (PRC)—cultural imperialism.

Prof. Junhao Hong notes that an unbalanced flow of media influence from a few Western sources, called cultural imperialism, does not cause so much economic damage as much as "the disruption of the basic social and cultural institutions of the [country]."[6] Therefore, China responds with extremely tough domestic regulation on satellite broadcasts, codified through a number of national laws.

The following major domestic laws highlight specific restrictions on satellite broadcasts—many more limit content and conduct of media providers:

Measures on the Administration of Foreign Satellite Television Channel Reception (2004.08.01)

- Article 3: With the approval of the State Administration for Radio, Film and Television, foreign satellite television channels may be received by such designated places as three star and higher hotels for foreign guests, places specifically for foreigners to work and apartments set up for foreigners and other specified places.
- Article 4: Applicants to distribute foreign satellite television channels shall have the following qualifications: . . . (4) The

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channel which is being applied for and its directly related agencies shall be friendly toward China, and have long term friendly broadcasting exchanges and cooperation with China.

- Article 6: Regarding a foreign satellite television agency, it shall in principle only receive approval for a single channel with a specific scope to be distributed, and in principle no foreign satellite television news channels shall be approved to be distributed domestically.[7]

Notice Regarding Strengthening the Administration Work of Provincial Level Television Satellite Program Channels (2000.01.30)

- Satellite television channels shall strictly observe propaganda requirements, and firmly observe correct guidance of public opinion. With respect to reports on important events, breaking stories and other sensitive issues, they must obey the integrated dispositions of the local party committee Propaganda Departments, and strictly abide by Party discipline.[8]

Regulations for the Management of Ground Satellite Television Broadcasting Receptors (1993.10.5)

- Article 9: Individuals may not install and use satellite Earth reception equipment.[9]

Chinese law enforcement works hard to enforce these laws. In an April 2004 raid, for example, authorities in Haidan District discovered that Hua Yian (Wild Goose) Communications was selling satellite reception equipment without permission. The subsequent raid netted 174 satellite dishes and other equipment valued at over 200,000 Yuan ($25,000).[10]

Change is coming, although slowly. China now allows foreign partnership with Chinese media companies, with state oversight. Based on Rupert Murdoch's News Corporation's successful pairing with Hunan Radio, Film, and Television Group and Li Kashing's TOM Group, private entities can be commercially successful in China, especially when media has regional talent and focus.[11] According to Kevin Latham, a media research di-

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rector, "One has to understand the logic of the Chinese system in its own terms, and if you put yourself in the position of a Chinese television producer, program planner or other executive who is resigned to not trying to upset the political boat . . . then they have enormous flexibility in program choice."[12] Complete deregulation of satellite broadcast content, it would seem, is unlikely anytime soon.

Enormous opportunities exist for those willing to respect the PRC's measured approach to progress, however. For equipment providers, World Trade Organization (WTO) reform is helping: import tendering was lifted on satellite Earth stations in 2004, enabling foreign import.[13] As for importing programming, David Leavy of Discovery Networks Asia explains, "We are a culturally and politically neutral channel with a focus on science and history and have never experienced any problems."[14] Successful ventures like this encourage broadcasters to redefine their approach when entering China's expanding market.

China's major domestic goal to operate independent satellite broadcast systems was understandable then, considering these issues. By owning and operating satellite broadcast systems capable of meeting national needs, the PRC precisely controls domestic media, allows cooperation where appropriate, and guarantees national profit from all ventures targeting China's consumers. Concurrently, broadcasters willing to respect China's culture and guidelines stand to profit accordingly. There is no doubt both institutions will be stressed as boundaries are drawn and challenged, but a unique environment is certainly developing in China like few others worldwide.

National-Security Efforts

China's Commission of Science Committee recently articulated China's 20-year goal to promote the national defense industry in support of national security. Through 2010, China's tenth five-year plan will form a foundation by reducing international disparity in weaponry research and production, as well as reforming organizational structures to achieve breakthroughs in national defense technology and economic efficiency.[15] The breakthroughs China seeks include national-security space

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systems not only to support its strategic initiatives, but as a measure of comprehensive national power as well.

One area of great development is in remote-sensing satellites. A Chinese company that leads such efforts is the Dongfanghong (DFH) Satellite Company. Mainly engaged in the research and development of small and microsatellites, DFH has already developed a universal satellite bus, the CAST968 platform, which can be applied to Earth and ocean observation, communications, navigation, and more.[16] During the tenth five-year plan (through 2010) DFH will launch a constellation of two optical and one synthetic aperture radar (SAR) satellites. Between 2010 and 2015, they intend to launch an eight-satellite constellation with four optical systems and four radar systems.[17] These revolutionary new systems will no doubt impact China's ability to use space to meet national-security needs.

Considering that 2004 saw a record number of "resources satellites, retrievable satellites, scientific experiment satellites, scientific exploration satellites, meteorological satellites and small satellites,"[18] China is already reaping benefits of increased investment. Supporting this ever-increasing battery of satellites requires improved command and control, but China is keeping pace with demand. Upgrades to its satellite-management system in late 2004 were independently developed by Xian Satellite Observation and Control Center, allowing "automatic adjustment of multisatellite observation and control plans and real-time automatic monitoring of the observation and control process."[19] Thanks to mid-2005 upgrades, "the data handling capacity of the center has increased by almost 8 times, thus the command and control capability of the center has been greatly enhanced."[20] China's rapidly expanding space fleet performs more missions than ever before—and indicates immediate goals to improve comprehensive national power are being met.

However, China's self-reliant stance and compartmentalized development may eventually hurt its struggle for systems comparable to those of other nations. Li Deren, Shu Peng, and six other remote-sensing professionals from the Chinese Academy of Science believe that high-resolution remote-sensing satellites are a critical development area for China. According to them, "space technology has become an important symbol of comprehensive national power."[21] However, their summary of

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issues with China's remote-sensing technology application includes the following highlights:

1. Chinese remote-sensing satellites are an order of magnitude less capable than western satellites.
2. China lacks a space navigation system to help pinpoint locations on the Earth.
3. China's remote-sensing layout lacks overall consideration [for military and civilian users], which leads to duplication of resources, omission, and waste of funds.
4. Satellite launching and applications have not yet formed commercial operations.
5. Because programs are dependent wholly on government investment and lack market motivation, units and individuals cannot give play to their initiative.[22]

Proposals to improve the direction of Chinese remote sensing are sweeping: they include establishing a military and civilian group to realize high-resolution, multispectral-satellite and radar-satellite constellations for civil and reconnaissance purposes. High technologies including improved orbit-and attitude-determination technology, wide-spectrum systems, miniaturization, data-relay satellites, and more are also necessary. Finally, they admit that launch and construction of satellites require government investment, but call upon China's remote-sensing data services to "strive as soon as possible to form a Chinese remote-sensing operation that faces the domestic and foreign markets with our country's remote-sensing systems."[23] This statement not only highlights the potential strife between China's remote-sensing communities, it also suggests the harsh reality that without commercial competition, rapid innovation may simply not be possible. This, in turn, could hurt China's ability to maximize its space capabilities in the national-security spectrum.

Military Space Power

The People's Liberation Army's (PLA) current and future participation in space programs that directly support military operations is shrouded in mystery. However, considering selected

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publications and what is known of China's national goals, the following details are inferred:

- Thanks to comprehensive national power, China's military will leverage a strong S&T base of technicians and facilities to build a savvy space cadre, perhaps even a dedicated space force.
- Once present, China's space professionals would execute a space control doctrine that evolves through three distinct phases:
  - Space is an information battleground: superior space navigation, reconnaissance, and communication systems must be integrated into military strategy.
  - Space is a physical battleground: direct combat power projection into space provides the ability to deny the adversary's space power.
  - Space enables combat power projection: Far-reaching technologies allow combat power to be applied globally and instantaneously.[24]

CNP, as described earlier, accelerates technological development by fostering talented people. This, in turn, reflects directly on the relative power of China—including its military prowess. Based on selected Chinese writing, military thinkers are discussing "space war" (天战); for some in China it holds great promise and has very vocal support. And, in order to win space war, one first must develop a very capable group of professionals.

Col Wu Tianfu, guest researcher at China's Military Academy of Military Science and Strategic Research Center, notes that in the "space war" century (the twenty-first century), one must "try the best to educate people with high-tech knowledge, to fit the need of space war in the next century, we need many, with high quality."[25] Such qualities include specialty training, taking advanced courses abroad, on-the-job experience, college and university education, and research-and-development skills. Accordingly, human resources, financial, and material support should be increased.[26] The training and education of capable soldiers is a key goal to prepare for space war.

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The PLA does not delay meeting these goals—efforts to develop highly talented soldiers began as early as 1999. For example, three military schools in Zhengzhou, Henan Province, were merged to create the PLA's Information Engineering University (IEU) to cultivate hi-tech warfare involving the use of information technology.[27] In addition to its numerous information security programs, the university offers courses in space positioning and remote sensing; it possesses space facilities, including a global positioning system (GPS) test ground, a satellite ground station, and a satellite observation station.[28] In late October 2004, as part of China's 2110 Project, a remote-sensing ground station was installed. According to reporters Shen Yi and Li Yuming, "the establishment of the station will play a positive role in improving the overall military photographic survey level and battlefield monitoring of the PLA, and in boosting the quality of the topographic personnel and in carrying out military-application research and theoretical study of world-oriented space remote-sensing technology."[29] The IEU characterizes the institutions that will produce China's first generation of space cadre.

Institutions like the IEU and others help China's officers and enlisted rapidly develop space savvy. For example, Wang Da and others from the National University of Defense Technology recently studied the ability of Analytic Graphics Satellite Toolkit (STK) to simulate space-ground integrated combat, noting that "study on the modeling and simulation of space-ground integrated combat has very important significance to the preparation of future military warfare."[30] In another example, 300 noncommissioned officers (NCO) at Jiquan launch site handle key launch operations, such as rocket fuelling. According to one NCO, "the fuel-filling was done by scientists personally, later this job was taken over by professional technical officers, and now this job is done by us NCOs. So in a sense, it is we who send rockets to space!"[31] Chinese soldiers obviously take space seriously and are proud of their accomplishments.

With a confident cadre of space professionals, a PLA space force is a likely development. The important question, then, is what will be China's space force's structure and doctrine? The structure of a space force, according to an article on China's National Defense Education Network, could consist of:

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1. Launch Troops: personnel that launch, inspect, test, and refuel spacecraft.
2. Control Network Personnel: widespread control assets, with both civilian and military personnel, track and control spacecraft.
3. Early Warning or Space Surveillance Troops: monitor hostile countries' spacecraft and ballistic missiles, track satellites, discover enemy intelligence efforts and provide early warning to a space commander, who could then order antisatellite satellites or missiles to intercept the threat.
4. Military Astronauts: a small group deployed in space, this group also manages, improves tactical control, detects, observes, and provides information on fighting—their role cannot be replaced.[32]

Regardless of the specific form chosen, any PLA space army will need a doctrine to guide operational and tactical commanders. That doctrine, some predict, will evolve through three distinct phases. The exact time line for such evolution is pure speculation; like any doctrine, it is often employed when required and is always subject to change. The point remains, though, that whether or not Chinese military thinkers are inventing this doctrine or simply regurgitating doctrine from outside China, they are internalizing the concepts key to building military space power.

The first distinct evolution of space-control doctrine treats space as an information battlefield, where one wages information warfare to achieve superiority. Though the terminology may be abstract, Chinese descriptions depict this kind of conflict as centering not on denying others, but acquiring and successfully integrating military space power into operational and tactical strategies. Prof. Yin Weibin and Prof. Wang Xingzhong note that information warfare enables rapid reaction and precise long-range strikes, and is decided by space-information superiority.[33] This information superiority includes possession of advanced reconnaissance, communication, and especially navigation technologies secure from interference. Li Jian and Sun Honglin, contributors to China's National Defense News-

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paper, warn of the dangers faced when information superiority is lacking or threatened. They claim Taiwan's lack of military space power is its weak spot because "Taiwan's military lacks aerospace-reconnaissance and satellite-communication methods, and especially because it lacks ballistic missile early warning satellites."[34] The authors also note Taiwan does not possess its own military communications satellites and must rent them from others.[35] From these examples we see Chinese doctrine development will first tackle the ways and means military space power can be integrated at lower levels of command. Once these challenges are met, doctrine can be expanded to meet its second set of goals.

The second phase of space war extends to "capturing" space power. Rather than focus on overcoming internal friction, this type of doctrine explains how the military space power of others is threatened. Chang Xiangqi explains that capturing space power is important because space systems' tactical integration with weapons systems increases daily. As more countries operate space systems, the resulting multifaceted environment will break the American and Russian space monopoly.[36] As simply put in the Shanghai National Defense Strategy Research Institute's *21st Century Space Soldiers and Space Wars*, "Obviously, space war is no longer a fantasy, it is a fact that cannot be avoided."[37]

There are varying methods proposed to capture space power, but ways, means, and potentially unique doctrine will probably fall into broad categories. One scheme lays out space war's four main modes (or styles) of combat, with examples:

1. "Acupuncture" point attacks: specialized attack, jamming, and destruction of the enemy's space-war command-and-control systems' important points, such as destroying the enemy's space-war control center or different kinds of spacecraft-control centers to attain the goal of destroying the enemy's star-wars control systems to paralyze the enemy.

2. Blinding attacks: using "soft" methods to make the enemy's "eyes," such as radar, communications, navigation, and electronic reconnaissance equipment, ineffective or blind.

Using one satellite to spray an opaque chemical on another satellite's sensors is an example of this attack.

3. "Kill-the-body" attacks: using interception satellites or space mines, usually hidden in a prearranged orbit, patrolling like a soldier on patrol. Once it discovers a target it can make a decision to, or on command, launch itself at the enemy target. The 1982 Soviet ASAT [antisatellite] test is an example of this attack.
4. "Attack-the-heart" attacks: using a kinetic-energy weapon or directed-energy weapon to attack the enemy's star-wars weapon systems' "brain" or "heart" (for example the computer, control system, or power sources and subsystems) to attain the goal of destroying the enemy's target. The 1997 Air Force laser test is an example of this attack.[38]

To enable these combat modes, high levels of technology and skilled people are required. It is noted that CNP and defense-modernization efforts are again core to the success of space-war doctrine.

Space war's third evolution focuses on its third, and most romantic, phase: actual power projection *through* and *in* space. Employing advanced technology like aerospace craft, space stations, space-depot ships, and high-power lasers, military space power may be used to capture military power.[39] According to Wu Tianfu, by 2030 or 2040 this could be a reality. He describes a situation in which a small detachment of space troops could physically assault a space station or attack the ground, which he says "will totally change traditional modes of combat on the ground."[40] It is pure speculation whether or not this kind of combat power can be developed so quickly, but it certainly is seen as an inevitable development in the course of warfare.

Regardless of the ultimate form of space war, proposed ways, means, and doctrine to support it are pursued today. According to Wu, "if we use space strategy and international strategy, then our influence and control of power will be increased in a big way, we can use space strategy to resolve some important international military issues."[41] This attitude reflects a desire for revolutionary developments in China's military space power.

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Those developments, in turn, will no doubt become key elements to consider when examining the space-strategic environment.

International Engagement

Despite the space-war doctrine military thinkers are developing, China is pursuing a concurrent and contradictory international effort to staunch a space-arms race. Currently known as the Conference on Disarmament Prevention of an Arms Race in Outer Space (PAROS) working paper, CD/1679, it includes the following key concepts:

- Not to place in orbit around the Earth any objects carrying any kinds of weapons, not to install such weapons on celestial bodies, or not to station such weapons in outer space in any other manner.
- Not to resort to the threat or use of force against outer space objects.
- Not to assist or encourage other states, groups of states, or international organizations to participate in activities prohibited by this treaty.[42]

To date, the Russian Federation is China's primary partner, along with Vietnam, Indonesia, Belarus, Zimbabwe, and the Syria Arab Republic. Canada, Sri Lanka, France, Sweden, and Italy have also proposed constructive measures on the topic.

Mr. Hu Xiaodi, ambassador for disarmament affairs of China, summarized the motivation for such a treaty at the United Nations (UN) Plenary of the 2003 Session of the Conference on Disarmament, "With the demise of the Antiballistic Missile (ABM) Treaty, the restriction by the international legal regime against the development and deployment of outer space weapons has been further eroded. As a matter of fact, there are no legal prohibitions whatsoever against the introduction of non-WMD [weapons of mass destruction] weapons [i.e., weapons other than nuclear, biological, and chemical] into outer space."[43]

In 2004, Mr. Hu noted, "such combat theories and concepts as 'control of outer space, power projection into and through outer space' as the R&D [research and development] of outer

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space weapons have found their ways into implementation." He added, "CD/1679 is still evolving and improving."[44]

In June 2005, China's Office of the Minister of Foreign Affairs affirmed China's continuing commitment on nonweaponization of space.

> The prevention of weaponization of outer space and any forms of arms race in outer space conduces to global strategic stability and promotes the process of arms control and disarmament. The international community should attach great importance to this and take vigorous and effective measures to forestall this danger. The Conference on Disarmament in Geneva should promptly set up an ad hoc committee for the negotiations and conclusion of relevant international legal instruments or work toward the objective of plugging the loopholes in the current legal regime of outer space and effectively preventing the weaponization of outer space and any forms of arms race in outer space.[45]

Do such statements mean China cannot develop space weapons at any point? Will it avoid preparations for space war? These issues are certainly considered seriously by China's national leadership. The situation is probably best summed up in a recent opinion piece on China's ability to build satellite jammers. According to the author, "we have the information, but don't have the ability to build a satellite jammer. We cannot let this plan come true, because the Chinese government is against a military contest in space. Therefore, we cannot determine what Beijing wants to do."[46] Simply put, China's future military space power will be influenced as much by domestic ways, means, and doctrine as it will be by perceived success or failure in its international efforts.

Although some may consider simultaneous progress towards space war and PAROS hypocrisy, China's leaders may benefit both ways. If PAROS succeeds, debate about weaponization might drop from international attention and delay worldwide interest in building more advanced military space power. This could provide China the time it needs to develop equitable CNP, credible technology, and be prepared for space war. Additionally, if space weapons are used against China in the meantime, the diplomatic mileage gained would be significant. If PAROS fails, however, the PRC could freely develop space-war concepts, reserving the right to take action without any international violation. Such could become major developments in the strategic-space environment.

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Whether China is developing a new strategy or employing the ancient concept of "fooling the emperor to cross the sea," the art of hiding intentions under the guise of everyday activities, remains to be seen.[47] China's clearly articulated interest in high-technology weapons and development of space-war thinking, when taken in this context, indicates its efforts should be closely monitored and seriously considered. At the same time, efforts such as PAROS should not be dismissed entirely—building trust and increasing transparency could result in the creation of new nonmilitary mechanisms that could help mitigate military space-power developments.

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Chapter 3

India

India pursues space technology to provide for its citizens, improve national security, give its military forces a tactical advantage, and boost its regional and international status. A world leader in space technology, the Indian space program is entering its golden age.

Domestic Environment

India is probably the world's best example of domestic space power used as a national means of improving citizens' lives. Its space programs encourage indigenous technological skill and offer new opportunities for industry and commerce; these benefits are shared with surprising equity, both within and outside of India.

The most crowning achievement of India's space systems to date is its highly successful constellation of Indian National Satellite (INSAT) communications spacecraft. With the 20 September 2005 launch of Edusat, the INSAT system has more than 130 transponders in C-band, Extended C-band, and K_u-band, providing a variety of telecommunication and television broadcasting services.[1] To put this in perspective, assuming industry standard data rates (DVB-S or the digital video broadcasting, satellite standard), INSATs can transmit up to 7 gigabytes per second over South Asia—the same as 125 million 56 kilobytes per second modems![2]

India uses this bandwidth to solve a longstanding problem: connecting its government with its people. In fact, India's government develops domestic satellite technology today for the same reasons radio broadcast was pursued in the 1930s. In *Satellites over South Asia*, David Page and William Crawley explain, "radio held out the prospect of an end to the touring of districts and repetition of messages, which was the daily routine of officials working in rural reconstruction."[3] That same goal is handled by satellite today, where in the state of Assam a "64-kilobits-per-second (Kbps) very-small-aperture-terminal

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(V-SAT)-based wide area network (WAN) interconnects the state, district and block administrative headquarters providing direct access to the Internet."[4] This concept, called "e-Governance," allows India to connect its large, dispersed population in a way not otherwise possible.

In addition to e-Governance and Internet connectivity, INSAT provides the more pervasive, and perhaps popular, service of broadcast television. Again, India's early days of radio offer a valuable insight. As radio developed in India, Frederick Brayne, a Punjab rural reconstruction commissioner, noted "the local dialect should be used and the matter must, for the most part, be familiar to the hearer in relation to his daily life."[5] That sentiment echoes today, for INSAT spacecraft carry programming in not only Hindi and English, but 11 other languages as well.[6] The Language Independent Programme Subtitles (LIPS) also allow India's state broadcaster, Doordarshan, to feed the same signal to all parts of India via INSAT with electronic subtitles in up to 20 languages.[7] It is no surprise that INSAT spacecraft are a commercially successful venture for the Indian government—television broadcasters clamor for more bandwidth to satisfy India's demanding and growing television audience.

India demonstrates that television is not merely for entertainment and advertisement, however, as its telemedicine and tele-education endeavors show. The September 2005 launch of Edusat, an INSAT dedicated to providing educational services, is a testament to India's commitment to use space for its citizens' benefit.[8] In a 2004 address in South Africa, Indian president, Dr. A. P. J. Abdul Kalam, who personally contributed over two decades of service developing India's space-launch systems, describes a tele-education service known as the President's Virtual Institute for Knowledge: "The connectivity is through V-SATs provided by Indian Space Research Organization (ISRO), Voice Over Internet Protocol and Internet. It provides for both synchronous and asynchronous communication, from text to voice, video; one-to-one, one-to-many and many-to-many connectivity. In this platform, the live virtual studio environment is created and it will connect a number of remote locations and provide seamless connectivity."[9] Such satellite technology enables India's institutions of higher learning direct access to students spread throughout India. In a similar fashion, telemedi-

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cine allows medical specialists to interface with patients hundreds of kilometers away. Considering the majority of patients are from India's rural areas, where only 2 percent of India's doctors practice, it is easy to understand that "this calls for innovative methods of utilization of science and technology for the benefit of our society and telemedicine assumes a great significance to revolutionize the health care system in India."[10] The satellite communications services INSAT provides are well poised to meet the demands of India's growth—not only in population, but quality of life and educational goals as well.

National-Security Efforts

India's serious pursuit of space to support national security was born in 1999, when Pakistan pushed into the Kargil-Dras sector in a limited war known as the "Kargil conflict."[11] As a RAND study described, "Kargil also occasioned reconsideration of India's perception of its security and its intelligence apparatus: in particular, Kargil strengthened the belief that Pakistani surprises can and will occur with potentially dangerous results and that they consequently merit anticipatory preparation in India."[12] As we will see, these themes reverberate even today, as India pursues space systems for national security.

India's own assessment of the Kargil conflict was captured in the Kargil Committee Report, which details events leading up to the event, as well as suggestions for improvement. Explaining why India did not detect advancing Pakistani troops, "a combination of factors prevented their detection: camouflage clothing; helicopter vibrations which hampered observation; opportunity for concealment on hearing the sound of approaching helicopters; and peace time safety requirements of maintaining a certain height above the ground and a given distance from the LOC [line of control]."[13] In addition, the primary organization responsible for external intelligence, the Research and Analysis Wing (RAW) was sharply criticized. As the committee stated, "It is neither healthy nor prudent to endow that one agency alone with multifarious capabilities for human, communication, imagery and electronic intelligence."[14] Based on the limitations of existing strategic surveillance techniques and

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faults in the intelligence system, the use of space systems in the national-security environment was primed for change.

The Kargil Committee noted that "Kargil highlighted the gross inadequacies in the nation's surveillance capability, particularly through satellite imagery. The Committee notes with satisfaction that steps have been initiated to acquire this capability."[15] Those steps ultimately resulted in the creation of the National Technical Facilities Organization (NTFO) in 2004. The NTFO is, in US military terms, India's executive agent for strategic intelligence, including the use of satellites to support that mission. The NTFO has an annual budget of $155.5 million, a higher-ranking director than any other Indian intelligence service that directly reports to the prime minister's office; the NTFO is clearly in a position to revolutionize India's space presence for national security.[16]

A key element of that revolution is India's drastically improving spacecraft systems. Its CARTOSAT-2 spacecraft can identify ground objects as small as one meter across and could revisit the same target in one day. India is also developing its Radar Imaging Satellite (RISAT) with a 3–50 meter resolution.[17] The availability of such high-resolution and radar systems, which provide all-weather day-or-night capability, could provide a major boost to India's national-security space power.

Broader national-security reforms may ultimately drive an increased use of space for national security. India's National Congress Party, for example, was vocally critical of its predecessor, the Bharatiya Janata Party (BJP)/National Democratic Alliance (NDA) government on reforms, stating that "the BJP/NDA Government's management of India's national intelligence institutions has been equally abysmal."[18] Before the April 2005 peace talks with Pakistani president Pervez Musharraf, the Indian prime minister, Manmohan Singh, was quoted as saying, "We must find technical ways and means to resolve all outstanding issues between us in a reasonable, pragmatic manner cognizant of the ground realities."[19] The technical means Prime Minister Singh suggests, combined with the reforms the Congress Party supports, will undoubtedly play a role in developing India's national-security space power spectrum. This new emphasis on national-security space power, in turn, will increase India's

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overall ability to use space power to keep its leadership informed on key issues, not only regionally but globally as well.

Military Space Power

India's military was affected by the Kargil conflict even more extensively than India's intelligence community: its soldiers and leaders fought the battles and suffered through a tougher environment than most will ever face. As India's national leaders discussed how to improve national security, India's armed forces began to focus on how stronger military space power could meet their immediate needs of maintaining a tactical edge over their adversaries.

The Indian Air Force's (IAF) struggle to create an Aerospace Command is the most characteristic example of how India's armed forces are developing a greater understanding of military space power. It is also an excellent example of challenges to the same. The concept of Aerospace Command was first articulated by IAF chief of Air Staff Srinivasapuram Krishnaswamy in 2003, when he said the service was considering the command to "link the force with the country's space-based assets like satellites."[20] However, more expansive uses of military space power were also being considered. Pakistan's *Daily Times* noted Krishnaswamy's comment on an orbiting weapons platform: "Any country on the fringe of space technology like India has to work towards such a command station because advanced countries are already moving towards laser weapon platforms in space and killer satellites."[21] Such a comment certainly fell outside of India's typically nonaggressive stance and was generally met with disapproval worldwide.

In response, less than three weeks later Air Chief Krishnaswamy retracted his bold statement. He stated, "We are prepared to use space for our own efficiency and projection in future use. They [satellites] will be used for command and control purposes and not for weapons delivery."[22] Still, Aerospace Command was not dead. As Krishnaswamy's successor, Chief of Air Staff Shashindra Pal Tyagi, noted in mid-2005, "It is time for India to have an aerospace command because our assets in space will grow. We in IAF understand that they require to be protected."[23] Yet again, Aerospace Command was tabled in

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September 2005—because of "large financial implications in the near term," as a senior Indian official put it.[24] It seems that India's willingness to allow the IAF to develop organic-military space power may be doomed to wax and wane for some time.

Aerospace Command retains a nucleus for the future, however, if in spirit but not in name. An IAF subcommand will be created, and India is exploring how to integrate space power as part of overall military strategy: "The Directorate of Concepts and Doctrines at HQ [headquarters], the brain behind the IAF's operational profile, has already started authoring a complex military space doctrine exclusively for the IAF's use, which, through the doctrinal cycle, will be eventually absorbed into the force's primary war doctrine. The doctrine will use inputs from IAF officers trained at the USAF [United States Air Force] Space Command training centre at Colorado Springs."[25] Within the next few years, the IAF will no doubt develop a comprehensive military space doctrine. Inputs from lessons learned in the Kargil Crisis, input from the USAF, and political encouragement or lack thereof will shape it to match India's needs.

International Engagement

India's long-standing tradition as a leader of the world's nonaligned movement and advocate for developing nations in the Asia-Pacific region infuse a distinctly international flavor into much of its space program. In addition, its strategic alignment with competitor/partners such as China, Russia, and the Unites States have varied over the years. At the moment, however, the most important development in India's international outreach is its recent partnership with the United States on key issues such as civilian space and missile-defense technology. A landmark joint statement, issued on 18 July 2004, describes the impetus for closer ties. "Prime Minister Manmohan Singh and President Bush today declare their resolve to transform the relationship between their countries and establish a global partnership. As leaders of nations committed to the values of human freedom, democracy and rule of law, the new relationship between India and the United States will promote stability, democracy, prosperity and peace throughout the world."[26] This agreement marks a relatively recent approach of openness

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on the United States' part, which India will leverage to augment its own space power capabilities.

Specific impacts on India's high-technology and space programs due to cooperation with the United States include:

- Joint research and training provisions and establishment of public/private partnerships, building on the US-India High-Technology Cooperation Group (HTCG).[27]
- Closer ties in space exploration, satellite navigation and launch, and in the commercial-space arena through mechanisms such as the US-India Working Group on Civil Space Cooperation.[28] To date, the Group proposes the following:[29]
  - o A multiple-hazards early warning and response system to serve national objectives of both sides.
  - o Cooperate on India's Chandrayaan-1 lunar mission.
  - o Promote interoperability between the US GPS, the US WAAS and the Indian Gagan satellite navigation-augmentation systems.
  - o Collaborate on a variety of Earth-observation projects involving the US National Polar-orbiting Operational Environmental Satellite System (NPOESS), Landsat, and IRS [Indian remote sensing] satellites.
  - o Cooperate in remote-sensing efforts such as the Group on Earth Observation.
  - o Explore complements in satellite-communications technology and applications, including telemedicine, tele-education, and space education and training.
- Remove certain Indian organizations from the Department of Commerce's entity list.[30] On 6 September 2005, the following ISRO organizations were removed:[31]
  - o ISRO Telemetry, Tracking, and Command Network (ISTRAC).
  - o Inertial Systems Unit.
  - o Space Applications Centre.

The following ISRO entities remain on the entity list:[32]

- o Liquid Propulsion System Centre.
- o Vikram Sarabhai Space Centre.
- o Satish Dhawan Space Centre (Sriharikota).

The results of these efforts so far are mixed. In one example, despite an improved ability to do so, collaboration between ISRO and Boeing is on hold. According to ISRO chairman G. Madhavan Nair, "They [Boeing] are not doing small satellite business anymore. They have changed their business plans. So, [the ISRO-Boeing initiative] is not going forward at this moment."[33] Despite the best international efforts, lack of commercial advantage can always halt cooperation.

In such areas as space-launch services, however, continuing cooperation with the United States may offer India new opportunities. No doubt ISRO welcomes the opportunity to avoid deal-breakers because of export-control restrictions. In 2001, for example, Taiwan's original plans to use India's polar satellite launch vehicle (PSLV) were scrapped after the United States forbade the launch unless Taiwan dropped high-tech satellite components from the ROCSAT-2 (Republic of China satellite now FORMOSAT-2 or Formosa satellite) remote-sensing satellite.[34] Future challenges for India and the United States were even noted by Jian Yan in a monthly publication of the CAS. According to Jian, "Cooperation is bilateral. Although India is a 'democratic country', and can become an important partner for the United States, it is also one of the world's most closed domestic markets. If the United States adjusts its policies, India may also make a corresponding adjustment."[35] Ultimately, India's success will depend on its technical prowess and reputation, combined with a desire to cooperate—both of which already indicate great promise.

Regardless of the opportunities and shortcomings India faces in the years ahead, one thing is clear: its commitment to developing space systems to meet national objectives will continue. India's space power must be taken seriously, for the sum of its domestic, national-security, and military spectra augmented with extensive international outreach will forge a significant independent space power in the years to come.

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Chapter 4

European Union

In January 2003, European research commissioner Philippe Busquin introduced the European Commission's (EC) *Green Paper*: European Space Policy. "Over the last few years, the Union became aware of the importance of space. It has been enhancing its role as an actor, in particular on the basis of applications useful to the conduct of its policies (e.g., the Galileo satellite positioning and navigation project) and the GMES initiative (Global Monitoring for Environment and Security) for observation of the environment and for security purposes."[1] First and foremost, this statement acknowledged that the European Union (EU) recognizes space as a strategic environment, and described what key areas the EU will focus on. Additionally, the *Green Paper* was meant to spark debate on Europe's space policy with both national and international organizations. As we will see, these initiatives are forming a unique space power that intends to leverage cooperation to achieve success.

There is extensive debate on the strategic importance of space within the EU today. Participants include national leaders, industry, consumers, the scientific community, and citizens. The EU believes that all players remotely involved in space must understand the larger picture of why space is important. The EU also recognizes that its system is fragmented. As the EC's November 2003 white paper *Space: A New European Frontier for an Expanding Union* describes, "The actual and potential benefits of space technologies cannot be fully secured under present institutional and budgetary arrangements."[2] Europe is taking steps to remedy the situation, however.

Numerous proposals to deal with outdated arrangements are weaving themselves through European doctrine and policy papers. Despite varying assumptions, most agree that intra-European cooperation is a necessity for future success. Efforts are already under way to normalize European space institutions, which could have significant impact on the EU's space power. For these reasons, although the EU is many individual

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nations, current developments warrant examining it as a cohesive entity when it comes to space power.

Domestic Environment

Europe has always shared strong commercial ties with the United States—European and American space systems have shared much philosophically and technologically. Due to a number of factors, however, the EU and its states are beginning to place greater emphasis on developing their own technologies and methods. Consequently, the United States and Europe are drifting apart in both the military and civilian space sectors as the EU looks to a revamped domestic space industry for revolutions in space power development.

The European cooperative rhetoric for space policy has been spearheaded primarily by the EU and the European Space Agency (ESA), who have been working for over two decades to integrate space into the EU's overall security and defense strategy. An integrated approach would bridge the gap between individual national space efforts. The EC's white paper laid the groundwork for that integration: it calls for a larger and more integrated funding pool for space projects while inspiring new European space efforts to provide advantages for defense and security, and to use the technologies of space to improve the quality of life for all Europeans.[3] In order to carry out the strategic plans put forth by the EC, the Space Council was established.

In November 2004, the first meeting of the Space Council was held to seriously discuss formulation of a European space policy. As Dutch minister for economic affairs Laurens-Jan Brinkhorst noted, "With the first EU-ESA Space Council Europe made a major step in the direction of a strong and coherent European Space Programme. Space technologies and applications will help Europe to reach its common goals in the field of i.e. competitiveness, environment and security."[4] A second meeting in June 2005 laid the groundwork for the Council's ultimate goal: endorsement of a European Space Strategy through 2013, to be ratified at the Council's November 2005 meeting.[5] Key proposals will certainly include mechanisms to better integrate Europe's domestic space industries as a precursor for building greater space power across the continuum.

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To modernize its industries, Europe's will improve research and development of dual-use space technology, increase overall spending for space, and champion "Europeanization" of its domestic industries. By enabling better cooperation between EU nations and their industrial consortiums and high-tech industries, Europeanization will result in a greatly improved industrial base to support space power development. A number of programs are already under way, including:

- AlphaBus: A joint venture between the ESA, Centre National d'Etudes Spatiales (CNES), European Aeronautic and Space Company (EADS) Astrium, and Alcatel Space. The AlphaBus communication satellite will bring advanced technology at lower costs to the world market by 2007; it is "a true product of European industry."[6]
- European Geostationary Navigation Overlay Service (EGNOS): ESA, the EC, and Europe's air-navigation system Eurocontrol are partnering on this satellite navigation-augmentation system, which paves the way for the Galileo satellite navigation system.[7]
- ESA's Technology Transfer Program (TTP):
  - o European Space Incubator (ESI): Recognizing many of the best industry innovations are developed into new products by small entrepreneurial companies, the ESI in Noordwijk, the Netherlands, provides office space, funding support, technical expertise, and research facilities to aid access to international markets, encourage cross-fertilization, and improve funding and investment opportunities.[8]
  - o ESI Network (ESINET): Through an intranet and other services, ESINET connects incubators and partners in 34 European countries.[9] Phillipe Busquin states it is "part of our offer to build a critical mass of scientific and technological excellence at EU level in order to create a true European research area."[10]

There are several barriers to a European integrated space policy, however. The primary obstacle is that not every member of the EU expresses the attitude or the involvement which is desired.[11] In order for the Europeans to fully integrate their

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space efforts, each state actor must contribute proportionally equal commitments. Simply put, each member is expected to provide adequate financial and policy backing on par with the benefits they receive from domestic space power. Since many European states do not have an equal ability to contribute, they may be forced to rethink decisions to join the European space club or go it alone. The ESA does not have the authority to enforce a European space policy. It has a problem similar to the EU, with its European Community Treaty, which stipulates that the defense sector is largely outside the scope of community authority and remains under the control of national governments.[12] Full European integration for space remains a challenge, but the effort to rebuild its domestic industries is a critical first step in achieving greater space power.

National-Security Efforts

Europe is developing a number of programs that use space systems to support national security. As the EC's 2003 white paper notes, "Space technologies lend themselves well to address questions which are of large-scale and global nature. Space is not the answer to every problem, but it should occupy an important place in Europe's policy toolbox."[13] GMES is just such a tool, and will be the EU's primary method to exercise national-security space power.

The GMES system provides an autonomous European capacity for Earth observation and monitoring by bringing together space assets that exist on a national or bilateral basis.[14] GMES is expected to support both civil and military national satellites used for security purposes and to enhance imagery and mapping capacities. As Phillipe Busquin and Jean-Jaques Dordain describe, the "GMES initiative represents, in simple terms, a concerted attempt to produce better policy relevant information."[15] On 3 February 2004, the EC adopted the 2004–08 action plan which establishes a GMES capacity by 2008. In addition, the EC's Strategic Aerospace Review (STAR) 21 Report also called on the EU to ensure European autonomy by developing GMES.[16] The ability to operate an independent, autonomous space system for national security will be a major development in Europe's national-security space power.

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There are numerous satellite systems available to Europe for the GMES system, which will employ a unique federated system. According to the European Institute for World and Space Affairs (EIWSA) *GMES Financial and Technological Assessment*, "technologically GMES, at least in the medium term, rather than running its own satellites, will rely on the satellite systems deployed by the national EU-member states—such as Italy's Cosmo-SkyMed (constellation of small satellites for Mediterranean basin observation-satellite-based Continuing Medical Education) (2005–07), France's Helios I and II (2003–04) as well as Pléiades (2006–08), Germany's SAR-Lupe (synthetic aperture radar—German for magnifying glass) and Telestart (2004–?)."[17] The Cosmo-SkyMed system, as an example, will be a major contributor. The *Assessment* notes, "The currently developed Cosmo-SkyMed project will be crucial for the EU monitoring capabilities of the Mediterranean sea and adjacent territories."[18] Not only does Cosmo-SkyMed demonstrate European dual-use design philosophy, it highlights Europe's plans to rely on cooperation to achieve its national-security goals.

Cosmo-SkyMed is an Italian Space Agency (ASI) system first proposed in 1997 as a dual-use system based on a constellation of four small satellites. Equipped with either radar or optical sensors, it supports national security, risk management, and environmental monitoring missions. System requirements highlight the utility of the system for national-security missions:

- High-quality imaging (less than one-meter resolution)
- High-accuracy geolocation
- Fast response time
- All-weather day-or-night acquisition capability
- Wide-area collection with along-track stereo acquisition
- Global access[19]

The most significant feature of COSMO-SkyMed is not technical in nature, however. The fact that it is totally European-born and designed to integrate with other EU nations' systems is telling of Europe's new approach to space use. The *GMES Assessment* states, "The Italian officials have envisaged from the

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beginning of the COSMO-SkyMed programme to open it up to other European partners. The COSMO radar component would be complementary initially to the [French] Helios optical satellites and later with Pléiades."[20] This kind of partnership lays the groundwork for a Europe in which national-security space power will have greater influence over its policy makers.

Military Space Power

It is challenging for a nation to completely share its military space capabilities with others, even close EU partner states. However, there is one collaborative European space program that clearly leverages partnership to improve European military space power: Galileo.

European independence is the chief reason for developing Galileo. Although Galileo can work with GPS and the Russian GLONASS (ГЛОНАСС—ГЛОбальная НАвигационная Спутниковая Система; transliteration: *GLObal'naya NAvigatsionnaya Sputnikovaya Sistema*; translation: GLObal NAvigation Satellite System) to improve accuracy, the constellation's orbital configuration gives it better coverage over Northern EU countries.[21] Galileo is a joint initiative between the European Commission and ESA, uses a network of 30 satellites, and is expected to be operational by 2008. Galileo offers Europe high-fidelity positioning, navigation, and timing (PNT) services, with an unprecedented real-time location error within the meter range.[22] Prior to the launch of Galileo, satellite navigation users in Europe have no alternative other than to take their positions from US GPS or GLONASS satellites. From a European perspective, neither of these systems provides guaranteed service—a serious drawback for Europe's military forces.

To counter that drawback, Galileo will use the jam and spoof-resistant public regulated signal (PRS), which is encrypted and not commercially available.[23] Europe plans on using Galileo's PRS to support regional military actions, such as Petersberg-type operations. These operations include tasking combat forces to execute humanitarian, rescue, and peacekeeping missions using a number of national and multinational forces.[24] Lindström and Gasparini provide some examples of how Gali-

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leo could support EU military activities in an European Union Institute for Security Studies (EU-ISS) occasional paper:

> For example, during low-intensity Petersberg-type operations Galileo could be used to monitor troop movements (given adequate tracking devices), facilitate the transport of supplies, establish perimeters, etc. For high-end Petersberg operations requiring the use of force, the positioning system could be used for traditional GNSS tasks such as logistics planning, targeting and munitions guidance. Under both types of operations, reliance on the PRS signal would be advantageous given the possibility to use it asymmetrically.[25]

Galileo's design guarantees access for government and military users in Europe. Access to a high-quality, secure, and reliable navigation service in the form of Galileo greatly enables European military space power regionally. However, Galileo is more than just a regional effort—it has a significant international aspect as well.

International Engagement

Galileo not only impacts Europe's military users—it can be argued its primary purpose is to leverage European space power through international means. Despite concerns over GPS and Galileo duplicity, the EU sees Galileo as an inherently international system and global alternative to GPS. In this sense, Europe is carving out a portion of international power the US currently enjoys through its operation of the GPS system.

In 2002 the United States expressed concerns over Galileo regarding interference and interoperability with the GPS system.[26] It was also noted, "The United States has made its system available free of charge to non-military users since 1983 and sees 'no compelling need' for the European version because it believes the United States system will meet the needs of users for the foreseeable future."[27] The EU, however, recognizes that many other nations are hesitant to integrate their national infrastructures with GPS alone. Galileo therefore encourages a more multipolar environment in satellite navigation technology. In the following two examples, Europe's international efforts with Russia and separately with China reveal Europe's plan to build better space power through cooperation.

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In the first example, Europe is leveraging Russia's expertise in operating space systems. The ESA and Russian Aviation and Space Agency (Российское авиационно-космическое агентство, commonly known as Росавиакосмос or Rosaviakosmos) view global satellite navigation as an area of mutual interest, and Galileo was specifically cited as an area for cooperation at the 15th Annual EU–Russia Summit in May 2005.[28] Russia's experience in operating its own navigation satellite system is a major benefit because "Russia's experience in operating a highly accurate navigation system and the European Union's strength in providing the technologies required for both space- and ground-based segments create the conditions for a very fruitful collaboration."[29] In addition, Russia will use its Soyuz launch system to place the two prototype Galileo systems into orbit.[30] Europe recognizes that a strong international agreement with Russia can give Galileo a tangible boost—Russia's experience and technology will be leveraged to improve Europe's program.

Just as Europe leverages Russia's experience, China hopes to leverage Europe's willingness to cooperate internationally and provide new technology and training to its partners. The EU and China signed an agreement in September 2003, where Loyola de Palacio, vice president of the EC, stated "China will help GALILEO to become the major world infrastructure for the growing market for location services."[31] China's S&T minister Xu Guanhua added that "China supports GALILEO and plans to participate actively in its construction and application for mutual benefits."[32] Sino-European cooperation and the EU's goal to supplant GPS as the "major world infrastructure" are very characteristic of the rapid development of multipolar trends in the space strategic environment.

Europe and China facilitate cooperation through the China-Europe Global Navigation Satellite Service (GNSS) Technology Training and Cooperation Center (CENC). Founded by the Ministry of Science and Technology (MOST) of the PRC, the EC, and the ESA, its goals are

- To offer the Galileo network service
- Support a GNSS Center
- Provide GNSS information

- Coordinate unified study campaigns and GNSS application exploitation
- Organize GNSS training
- Support temporary or specialty GNSS campaigns[33]

The National Remote Sensing Center of China (NRSCC) provides support and is responsible for two Galileo procurement actions: the medium Earth orbit local user terminals (MEO-LUT) that will locate and relay Galileo's distress signals, and search and rescue link end-to-end validation.[34] In a related effort, the European EGNOS augmentation system is already tested in China. In 2004 a triangular EGNOS service area was deployed that improved the quality of GPS signals within by a factor of three.[35] Considering China's goal to develop CNP, the support, technology, and training provided by the European Galileo effort are welcome developments.

By examining EU efforts to develop its international power, provide for its national-security and military needs, and Europeanize domestic space industry, we recognize a new formula at work. By focusing on cooperation, Europe as a whole can benefit from space power far beyond what any single nation could hope to achieve. Based on the evidence presented here this formula may be a winning one for the EU, enabling it to become a truly independent space power.

Notes

1. EC, *Green Paper*.
2. EC, *Space*.
3. Ibid.
4. ESA, "First Ever."
5. ESA, "Further Steps."
6. ESA, "Alcatel Space and Astrium."
7. ESA, "Safer Train Circulation."
8. "ESI Overview," *European Space Incubator*.
9. About the European Space Incubators Network," *ESINet*.
10. Silvestri, "Space and Security," 11.
11. Ibid.
12. Ibid., 17.
13. EC, *Space*.
14. ESA, "What is GMES?"
15. Ibid.

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16. Center for Nonproliferation Studies, “European Union.”
17. European Institute for World and Space Affairs (EIWSA), “GMES.”
18. Ibid.
19. Rum, “The Interest of a Constellation,” 53.
20. EIWSA, “GMES.”
21. Lindström and Gasparini, “Galileo Satellite System,” 15.
22. ESA, “What is Galileo?”
23. Lindström and Gasparini, “The Galileo Satellite System,” 19.
24. Pagani, “New Gear,” 738; and North Atlantic Treaty Organization, “Implementation.”
25. Lindström and Gasparini, “Galileo Satellite System,” 21.
26. The United States Mission to the European Union, “US Explains Position.”
27. Ibid.
28. EC, “Satellite Navigation”; and EC, “EU and Russia.”
29. EC, “Satellite Navigation.”
30. EC, “Soyuz.”
31. “EU and China,” China-Europe GNSS Technology Training and Cooperation Center.
32. Ibid.
33. NRSCC, “About CENC.”
34. NRSCC, “Implementation of Galileo MEOLUT (Medium Earth Orbit Local User Terminal)”; and NRSCC, “NRSCC Documents.”
35. ESA, “EGNOS.”

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Chapter 5

Nature of the Space Environment

Examining China, India, and the European Union provides us invaluable insight into disparate elements of the space strategic environment. By applying Colonel Guillot's framework, we have shown how these parties use space to meet strategic goals, implicitly proving space power will play an ever-increasing role in the strategic environment. By "knowing the disparate components of the strategic environment," the first step in identifying strategic leadership challenges has been completed. The second step, Colonel Guillot says, is "understanding the *nature* of the strategic environment."[1]

The nature of the strategic environment is volatile, uncertain, complex, and ambiguous. Colonel Guillot shows how this nature makes special demands on the process of making consequential decisions.[2] These characteristics have been translated into actual space-power contexts for clearer observation, and each narrative section identifies the apparent critical areas for continued attention, action, and research.

Volatility

Volatility, in a broad sense, is not ordinarily associated with space power. As we have seen, many space programs require years of careful planning and thoughtful investment. Because of this, serious shifts in a particular nation's strategic space power usually occur with advance warning or advertisement. But, even well-understood systems can be unpredictable—an unexpected "trigger" event or seemingly unrelated conflict can cause rapid escalation of actions and reactions, resulting in violence. As Colonel Guillot stated, "The challenge for strategic leaders lies in anticipating volatile scenarios and taking action to avert violence." It is up to the strategic leader to form comprehensive plans that will bring a quick return to a peaceful and functioning state.[3]

Preventing volatile, violent scenarios from occurring in space was addressed early in the context of preventing space from

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becoming a Cold War battleground. In 1967 the Outer Space Treaty (OST) went into effect and now serves as the "basic framework on international space law."[4] The OST outlaws use of nuclear, biological, or chemical weapons in or from space or any celestial bodies. Space powers can focus on *using* space power rather than protecting or denying it; and because the magnitude of conflict involving violence in space can be expected to result in the destruction of the earth, protection of space power for its own sake has become a secondary issue. Furthermore, enforcement of the OST has been very lax, and settlements arising out of loss of national space power usually come about through international lawsuits or negotiations.

Although nobly intentioned, it is unlikely that agreements like the OST will weather multipolar space power. The OST was the product of Soviet and US agreement, which by Cold War standards was globally unanimous. As more nations use space, however, a multitude of standards of behavior will emerge. Will international treaties become unenforceable as multiple parties realize their own innate space "rights" to self defense, or will the treaties be replaced with stricter codes of conduct with greater international enforcement? As we have learned, PAROS represents a proposed evolution where nations will self-impose extensive restrictions on their space use to preserve the peace in space for all. Should self-restraint fail in the face of pressing particular national strategic needs, the challenge of de-escalating space conflicts will remain.

Avoiding volatile and potentially violent scenarios requires rigorous and clear-minded attention. It must be understood that there likely will be volatility leading to violence as a consequence of the implementation, proposal, or even conception of new methods of "capturing" space power. Conflicts may erupt because of perception of unacceptable risk to a nation's space power.

Current major international initiatives and even PAROS focus on attempting to prohibit conflict. Because the space strategic environment is volatile, however, international regimes should be pursued that acknowledge the possibility of conflict and address methods to bring about quick de-escalation and arbitration. If not, future strategic leaders may resort to "Gordian knot" solutions with little international coordination or co-

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operation. The results of these kinds of actions could be tragic and permanent.

Uncertainty

Uncertainty is a very familiar trait of the space strategic environment. Strategic leaders "face situations in which the intentions of competitors are not known—perhaps deliberately concealed. At other times, they will even have reservations about the actual meaning of truthful information. Their challenge is to penetrate the fog of uncertainty that hugs the strategic landscape."[5]

This uncertainty is intrinsic to space power. On one extreme, domestic and international efforts tend to be public efforts that benefit greatly from collaboration and open commerce. On the other, national-security and military space-power users tend to move in guarded circles with concealed intentions. Considering the impact of inevitable collaboration between these communities and other complicating factors, determining the true intentions of competitors is a major challenge.

Some interesting examples of how different nations may deal with such challenges have been presented here. China, through PAROS, proposes that strict self-regulation regarding the use of space weapons can limit international uncertainty for all. The PRC also avoids the chaos of foreign influence by favoring indigenous systems and limiting import and free use of space technology. India is taking the opposite approach by seeking the synergy of international partnerships as the first step in strengthening its own capabilities. The EU plans to build a Eurocentric space power structure that works around uncertainty by building independent, interoperable systems such as Galileo and GMES.

If the spirit of cooperation defeats uncertainty, there could be new opportunities on the horizon. It was asserted earlier that national-security space systems will become much more prolific. Currently, nations guard their space-based C4ISR capabilities closely, sharing only hazy hints at their contribution to decision making. In the future, however, nations may be more willing to share their technology and tradecraft with others. Although this seems to be an uncomfortable development for some, it could

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also prove beneficial. For example, data-sharing agreements could allow nations to jointly monitor and digest common concerns. By comparing independent assessments, analysts could then offer their leaders the best possible inputs. Alternatively, a coalition force may accept a member nation's C4ISR support, rather than troops or money, as a welcome contribution.

Because of possibilities like these and more, strategic space leaders should prepare to work with international partners in new ways, should cooperation become the global standard. Not only can a nation improve its access to space capabilities, but partnerships may offer improved robustness and flexibility over completely indigenous solutions.

Complexity

Examining a nation's domestic, national security, military, and international space efforts as disparate components is an excellent way to structure an analysis. What it does not expose, however, is the complex interdependence of each. By focusing on only the space segment of a given system, it is difficult to quantitatively determine its importance within much larger mechanisms. What elements of space power are "nice to have" and what elements are "need to have" capabilities? What impact will their presence or absence have on larger strategic conflicts? Understanding interdependencies like these make complexity the "most challenging characteristic" of the strategic environment.[6]

We have shown that space power provides invaluable and perhaps otherwise unattainable contributions to a nation's strategic power. For this to occur, however, space power must be successfully integrated into larger systems of systems. This poses a dual challenge for strategic space leaders: successfully integrate space power into their own key strategic systems, and understand how others accomplish the same.

Integrating space power into existing strategic systems is as much art as it is science. Local culture determines the kinds of workforce and infrastructure that will spring up with rapidly advancing technology, the changing user demands, and the evolving strategic requirements. There are different approaches to solving these challenges. China, for example, is developing institutions like the IEU to locally educate a space cadre capable

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of developing and executing space-war doctrine. Chinese institutions like the China Academy of Space Technology are focusing on using the latest technologies to achieve space information superiority. India, on the other hand, is seeking a more international approach, hoping to partner commercially with US companies and use US military doctrine as the foundation for its own. Finally, the European Union is implementing a coalition mechanism in which cooperation between multinational components is a prerequisite condition for effective space-power projection. Time will tell if these approaches are suited for their users, but one fact is clear: greater diversity in the means of achieving space power produces an environment ripe for revolution. If the strategic leader wants to benefit from new revolutions, lessons must be learned not just from local culture and infrastructure, but also across the global state of the art as well.

Understanding the process by which other nations build and integrate space power produces valuable lessons that can be applied locally. A second and equally important reason to understand space interdependencies is to help understand unintended consequences that may arise from seemingly straightforward actions. Driving factors as diverse as cultural imperialism, the demise of the ABM treaty, and Europeanization of high-tech industries have been shown to have direct, if unintended, consequences in the strategic space-power environment. Predicting actions and reactions requires integrative thinking. Colonel Guillot argues, "if leaders are to anticipate the probable, possible, and necessary implications of the decision, they must develop a broad frame of reference or perspective and think conceptually."[7] Therefore, cognizance must be paid not only to the details of how nations use space power, but to the *concepts* driving their actions as well.

Ambiguity

Differing international concepts driving space-power development ultimately produce the environment's final characteristic, ambiguity. Colonel Guillot describes ambiguity as coming "from different points of view, perspectives, and interpretations of the same event or information."[8] For space powers, this is exacerbated by the fact that close monitoring of the space envi-

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ronment requires expensive and complex systems—even so, it is possible for events to occur without warning. Attribution and interpretation are also difficult tasks—how does one distinguish intentional attacks from accidents? Furthermore, what weight will a claim carry if third parties cannot verify that a particular event ever occurred?

Ambiguities like these continue to fuel international debates on space power, its value, and how it is changing. Just as the environment can be broken into domestic, military, national security, and international elements, friction and conflicts will emerge from their various participants as well. Because of this, strategic leaders should realize the value of using a team-based consensus to "help eliminate ambiguity and lead to effective strategic decisions."[9] It is doubtful these debates can be quickly resolved, but the space leader can count on one thing: the multipolar nature of space power will make both local and international teamwork essential to producing effective strategic decisions.

Conclusion

Many nations are advancing their use of space to meet domestic, national-security, and military needs—this proves space power is becoming an increasingly important strategic environment. Case studies examining the unique space power of China, India, and the European Union conclude that the strategic environment will become increasingly multipolar, offering new challenges for the strategic leader. Colonel Guillot's model for strategic environments demonstrates that this will require overcoming the volatile, complex, uncertain, and ambiguous nature of the space environment.

Although local paradigms will be challenged, leaders should prepare to leverage global advances in the state of the art at home, build more stable and less vulnerable space power through carefully developed cooperation, and create effective means for de-escalation of space-based conflicts if and when they occur. Internationally, these trends are already at work and redefining the strategic landscape. Regardless of its final form, international engagement in a multitude of forms will be necessary to achieve and maintain space power now and in the future.

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1. Guillot, "Strategic Leadership."
2. Ibid.
3. Ibid.
4. "Treaty on Principles Governing the Activities of States," United Nations Office for Outer Space Affairs.
5. Guillot, "Strategic Leadership."
6. Ibid.
7. Ibid.
8. Ibid.
9. Ibid.

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